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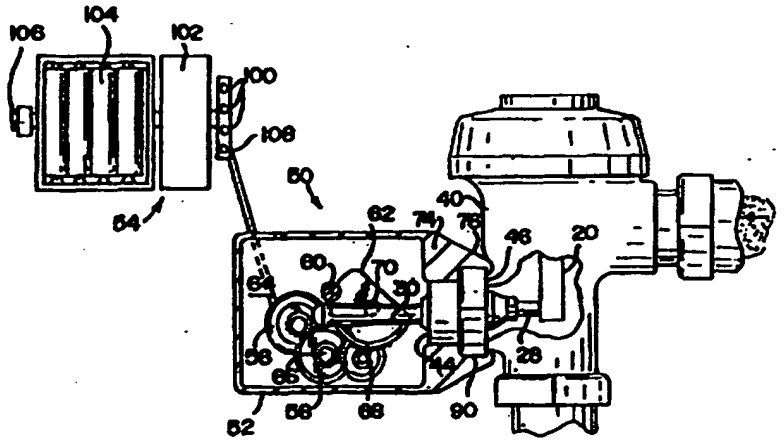

(57) Abstract

A drive mechanism (50) for a flushing mechanism (10) having a flush handle (30) includes a housing (40) with a battery operated drive system in the housing. The drive system has an actuating element (28) which is operably connected to the flush handle (30), which is encased in the housing, whereby the drive system operates the flush handle between a first non-actuating position and a second flush actuating position. The housing (40) is removably mounted to the flushing mechanism such that the housing is restrained against movement relative to the flushing mechanism when the actuating element is moved between its first and second position. A sensor (100) connected to the housing (40) and a timing circuit (200) inside the housing (40) operate the drive system upon sensing a use of the sanitary system to which the housing is attached.

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AUTOMATIC FLUSH VALVE ACTUATION APPARATUS

The present invention relates to automatic flush valve actuation devices for toilet and urinal facilities, and in par-ticular to add-on flush valve actuation devices that are adapted to be readily and easily attached to existing flush valve mechanisms.

Background of the Invention

Public awareness of personal hygiene and water conservation issues over the last several years has initiated a response by manufacturers of public and private sanitary and water use facilities to develop systems that eliminate human contact with environmental surfaces that may contain disease spreading bacteria and to control flush water usage to eliminate waste.

Many present toilet and urinal flush devices for sanitary facilities are operated by a water control valve including a manually operable flush handle adapted to be gripped and moved by a user following use of the sanitary facility. A typical valve arrangement is shown, by way of example, in U.S. Patents Nos. 2,776,812 and 3,399,860. However, those valve actuation devices present several

problems. Among these problems are the fact that with an enlightened awareness that public sanitary facilities may have been previously used by someone having a communicable or other disease that is spread upon contact, individual users of the sanitary facility are becoming reluctant to touch the flush handle and risk becoming ill. Therefore, the sanitary facility may remain unflushed, leaving human waste products in the toilet and urinal, obviously increasing the unsanitary conditions, and fouling the atmosphere in the facility. Therefore, having flush mechanisms that people won't use can lead to extremely unsanitary and undesirable conditions.

In addition, many present flush handle operated valve mechanisms for sanitary devices are constructed such that the user can hold on to the handle for an excessive time period, retaining the valve mechanism in an open position longer than necessary to flush the toilet or urinal. This obviously wastes water, which can be a major problem in those parts of the world where water is increasingly becoming a scarce commodity. Also, excessive water use leads to additional and unnecessary costs for the entity installing and maintaining the washroom facility.

Several systems have been developed in an attempt to address the hygiene and water control problems of existing manual flush control mechanisms for sanitary facilities. These include structures which totally replace the manually operated flush valve mechanism with an automatic, sensor actuated flush valve operation device that is also connected to the 110 volt electrical system extant in the facility.

Such a system is shown in U.S. Patent No. 4,793,88. However, the replacement of existing manually operated flush handle devices with such units is very costly, particularly in buildings such as hotels, office buildings and the like which presently have installed numerous manually operated flush mechanisms in their sanitary facilities. Such replacement would require the work of mechanical and plumbing personnel, and the installation cost of replacing numerous manually operable flush devices with automatic devices of the type disclosed in U.S. Patent No. 4,793,588 would be prohibitive. Also, this replacement project would require a shut down of the water supply system or turning off water to the valve until the valve mechanisms could be replaced, which is undesirable in large hotel, office, and other structures. Additionally, building permits would be required for such a replacement project.

Another attempt to automatically operate a manual flush valve mechanism for a sanitary facility is shown in U.S. Patent No. 3,056,143, which discloses a door operated electrical solenoid device for depressing a manual flush handle each time the door tc the toilet stall is opened. However, the device shown in Patent No. 3,056,143 has many shortcomings. The existing valve housing in the prior art structure would have to be disassembled, re-worked and retrofitted to accept the bracket supporting the solenoid. This requires reconstruction of the valve housing. Also, the cantilever nature of the reference mounting structure will result in possible movement of the bracket upon actuation of the solenoid, and

improper actuation of the flush handle. Further, the reference device is tied to the electrical system of the building in which the stall is located, requiring added installation costs. The reference device will operate each time the door opens, whereby the flush mechanism will operate twice for each use. This waste could be significant, considering that sanitary facilities are operated 4,000 times per month in many installations. Additionally, in the reference device, the existing flush handle remains exposed, whereby the handle can be manually operated or kicked, as some users are prone to do to avoid touching the handle. This exposure of the handle can also lead to water waste through manual operation.

Therefore, it is an object of the present invention to provide an automatic flush valve actuation apparatus to be installed and mounted on existing manual flush valve mechanisms without requiring any mechanical work or structural changes to the existing manual flush mechanism.

It is a further object of the present invention to provide an automatic flush valve actuation apparatus which can be readily mounted to existing flush valve mechanisms, whereby the flush valve actuation apparatus engages a portion of the flush mechanism housing to prevent rotation of the actuation apparatus during operation.

Another object of the present invention is to provide a battery operated flush valve actuation device for a sanitary unit such as a toilet or urinal, which requires no connection to the extant electrical system of the installation in which the sanitary unit is located.

An additional object of the present invention is to provide an automatically operated actuation device for existing sanitary unit flush handle mechanisms which can be actuated by sensors responsive to use of the facility, and by timing devices that automatically actuate the flush handle at predetermined time intervals.

Yet another object of the present invention is to provide an automatically operated flush valve handle actuation device in a compact, self contained unit which can be readily attached to an existing manual flush valve mechanism on existing sanitary units without the need to connect the actuation device to any outside power or control sources.

A further object of the present invention is to provide a compact self contained flush valve handle actuation device which is automatically mounted on and aligned with the existing flush valve housing structure, whereby the mounting structure provides the necessary torque to enable the operating mechanism inside the flush handle actuation device to overcome the spring pressure acting on the flush handle and to depress the flush handle.

Summary of the Invention

These and other objects and advantages of the present invention are provided in an apparatus for automatically actuating the flush handle of the flushing mechanism of a sanitary device, wherein the flush handle extends outward from the flushing mechanism. The flushing mechanism includes a flat exterior surface adjacent a connecting element which

connects the flush handle to the flushing mechanism. A tension device is disposed between the flush handle and the flush mechanism to urge the flush handle back to a non-flush first position after the flush handle has been moved to a second flush position by the automatic flush handle actuation mechanism. The present invention provides a compact housing having a battery operated, motor driven flush handle actuation mechanism in the housing which moves the handle to the second flush position when the motor is activated.

A sensor connected to the housing and a timing circuit inside the housing of the present invention, operates the motor upon sensing a use of the sanitary facility to which the housing is attached. The timing circuit also enables the sanitary unit to be flushed at predetermined intervals irrespective of use, where it may be desirable to add and remove anti-bacterial and cleaning agents to the sanitary facility at night when the unit is not being used. The housing is removably mounted to the flushing mechanism and includes a flange surface abutting a flat surface of the flushing mechanism which prevents the housing from rotating or otherwise moving relative to the flushing mechanism to provide the necessary torque to the motor driven handle actuation device inside the housing.

In a preferred embodiment of the invention, the flush handle is contacted by a post or hammer type mechanism which rotates through a small arc after the motor is furnished with a short pulse of electrical energy from the batteries. The tension device in the flush mechanism then returns the

flush handle and the post or hammer type mechanism to its original or non-flush position.

In another preferred embodiment of the invention, a cam device contacts the flush handle, and the cam device rotates through 360 degrees after the motor receives a short pulse of electrical energy from the batteries. A switch and latching circuit then connects the electrical power to the motor, which continues the rotation of the cam. The cam surfaces are designed to initially depress the flush handle, then to allow the tension device of the flush mechanism to raise the handle back to its non-flush position.

The present invention is adapted to be readily installed over existing manually operated flush handle mechanisms, without the need to disassemble any of the existing flushing mechanism structure or shut off the water supply. The present device can be installed or removed in a matter of moments, using simple hand tools, and no external plumbing or electrical connections are required.

By eliminating any intrusion into the valve mechanism itself, the present invention can be mounted onto an existing flushing mechanism without causing the possibility of leaks. Also, the present invention can be installed by a building's present maintenance staff, without the requirement of building permits. The housing of the invention encapsulates the flush handle, thereby isolating the handle from manual use, or kicking. The housing is also stable against rotation and lateral movement relative to the flushing mechanism.

Brief Description of the Drawings

FIG. 1 is a cut-away front elevational view of a flush valve mechanism assembly as commonly found in the prior art for manually flushing sanitary units such as toilets, urinals, and the like;

FIG. 2 is a schematic view of one embodiment of the automatic flush handle actuating mechanism of the present invention showing the power/circuit module, the actuating module, and the flush valve, with the handle actuating mechanism in a de-actuating position;

FIG. 3 is a schematic view of the flush handle actuating mechanism of FIG. 2, without the power/circuit module and showing the handle actuating mechanism in its actuation position;

FIG. 4 is a schematic view of another embodiment of the automatic flush handle actuating mechanism of the present invention showing the power/circuit module, the actuating module and the flush valve, with the handle actuating mechanism in a de-actuating position;

FIG. 5 is a schematic view of the flush handle actuating mechanism of FIG. 4, without the power/circuit module, and showing the handle actuating mechanism in its actuation position;

FIG. 6 is an external front elevation partially cut-away view of the automatic flush handle actuation device of the present invention mounted to a standard flushing mechanism, particularly illustrating the flange extension of the handle actuation device housing which abuts a flat surface on

the flushing mechanism housing to hold the handle actuation device against rotation; and

FIG. 7 is a perspective detail view of a portion of the modular housing unit of the present invention, showing the brackets for mounting the modular housing unit to the flushing mechanism housing.

FIG. 8 is a circuit diagram of the power/circuit module of the present invention.

FIG. 9 is a circuit diagram of the power/circuit module under an alternate embodiment of the present invention.

FIG. 10 is a circuit diagram of the power/circuit module under a second alternate embodiment of the present diagram.

Description of the Preferred Embodiment

Referring to FIG. 1, a flushing mechanism commonly found in the prior art for flushing sanitary units such as toilets and urinals is designated by the numeral 10. Flush water is supplied to the flushing mechanism 10 through an intake port 12, and the water is delivered to a chamber 14 normally closed off by a valve 16. Leading from valve 16 is a water delivery pipe 18 which leads directly to a sanitary unit, such as a toilet or urinal (not shown).

The valve 16 includes a stem 20 which extends downward in pipe 18. The upper portion 22 of stem 20 is connected to a tiltable valve operating mechanism 24. The lower portion 26 of stem 20 is adapted to be contacted by a moveable plunger pin 28, which is mechanically connected to a flush handle 30 through a partial ball joint linkage mechanism

32. When flush handle 30 is manually moved through the arc 34 from its first position, shown in FIG. 1, to a second downward position (FIG. 3), plunger pin 28 moves to the right, contacts lower end 26 of stem 20, and tilts stem 20 to the right, as viewed in FIG. 1. This tilting movement of stem 20 causes valve 16 to pivot about point 36, thereby opening water delivery pipe 14 to the passage of flush water from chamber 14 and through pipe 18, thus flushing the sanitary unit.

A tension device, in the form of compression spring 38, is compressed when flush handle 30 is moved through arc 34. When manual pressure on handle 30 is released, spring 38 urges handle 30 back to the position shown in FIG. 1, thereby allowing stem 20 to return to its vertical position and close off valve 16. This halts the flushing operation through pipe 18. It has been determined empirically that a force in the range of four to eleven pounds is required to move flush handle 30 through arc 34 against the force of spring 38.

Referring to FIGS. 1 and 6, flushing mechanism 10 is encased in a housing 40 which has an opening 42 through which flush handle 30 extends. Opening 42 resides in a circular bushing 44 which is removably attached to housing 40 by a threaded nut 46. In most instances, nut 46 has a hexagonally shaped outer surface for engagement by an ordinary open-end wrench. Housing 40 includes a pair of external front and back flat portions 48 (FIG. 6) which form part of the casing comprising housing 40. In FIG. 6, only the front flat portion 48 is visible. The back flat portion of the housing is directly behind the front flat portion 48 shown in FIG. 6.

One preferred embodiment of the automatic flush handle actuation device of the present invention is illustrated in FIGS. 2, 3 and 6, and is designated generally by the numeral 50. The flush handle actuation device 50 is comprised of two major components, i.e.: a modular housing unit 52 and a power/circuit module 54. The housing unit 52 is adapted to be easily mounted onto flushing mechanism housing 40 over flush handle 30 in a manner to be explained. Internally of modular housing unit 52 is a motor 56 which is mechanically connected through a reduction gear train 58 to an actuating element (pin 60) which is mounted on gear 62 of reduction gear train 58. As motor 56 is activated, gear train 58 rotates gear 62 in a counter-clockwise direction, as viewed in FIG. 2. Pin 60 moves downward, contacting flush handle 30, and moving flush handle 30 downward to the position shown in FIG. 3. This moves plunger pin 28 to the right, tilting stem 20 and activating flush mechanism 10. As will be explained in further detail, compression spring 38 (FIG. 1) returns flush handle 30 to the position shown in FIG. 2 after power to motor 56 is cut off.

Motor 56 is rigidly mounted to a side wall 64 of housing 52. Likewise, the elements of gear train 58 are rotatably mounted on shafts having axes 66, 68 and 70, which are rigidly mounted on side walls 64 of housing 52. Any reverse torque applied by spring 38 through flush handle 30 during operation of motor 56 and movement of the flush handle from the position shown in FIG. 1 to the position of FIG. 3 is resisted by pin 60, gear train 58 and motor 56 acting through

housing 52. For that reason, the present invention provides a rigid, while readily removable mounting structure between modular housing unit 52 and flushing mechanism housing 40.

To this end, referring to FIGS. 1, 2, 6 and 7, modular housing unit 52 includes a cradle-shaped mounting bracket rigidly attached near one end of housing 52 which is to be attached to flushing mechanism housing 40. A flange portion 76 (FIG. 7) extends from housing unit 52 beyond the location of bracket 74. Bracket 74 includes a semi-circular cut-out portion 78 adapted to fit around half of the outside portion of bushing 44. A separate bracket 80 having a semi-circular opening 82 is provided to engage bracket 74 such that opening 82 extends around the remaining half of bushing 44 when modular housing 52 is mounted on flushing mechanism housing 40. A pair of screws 84 are provided to readily allow bracket 80 to be attached to bracket 74 by use of an ordinary screwdriver.

As best seen in FIG. 6, when brackets 74 and 80 mount modular housing 52 to flushing mechanism housing 40, flange 76 extends over and engages the back flat surface 48 of housing 40, thereby preventing modular housing 52 from rotating relative to flushing mechanism housing 40. The inside of brackets 74 and 80 include a cut-out portion 90 in the shape of hexagonal nut 46, which cut-out portion engages the outer surface of nut 46 and also assists in preventing rotation of modular housing 52 relative to flushing mechanism housing 40. A further cut out portion 86 in brackets 74 and 80 are configured to engage circular bushing 44 to further

assist in rigidly mounting modular housing 52 to flushing mechanism housing 40.

Operation of the automatic flush handle actuation device 50 occurs under any of a number of predetermined events. One such event is use of the sanitary unit. Another event may be non-use of the sanitary unit for some predetermined time period. Upon the occurrence of one of the predetermined events, a signal generating means activates the automatic flush handle actuation device 50.

Referring to FIG. 2, one signal generating means includes a sensor for detecting use of the sanitary facility. The sensor may be a motion detector 100, infra-red sensor, or a body heat detector. Upon detection of use by the sensor, an electronic control means (circuit board 102) inter-connected between a power source 104 and drive mechanism 50 within the modular housing unit 52 provides a pulse of electrical energy to the motor 56 of such duration as to rotate the gear 62 through a predetermined arc, at which point the motor stalls. At the end of this arc, power to motor 56 is cut off, and spring 38 raises handle 30 upward to its closed position. Pressure on pin 60 causes gear 62 to rotate clockwise from the position shown in FIG. 3 to the position shown in FIG. 2. In the preferred embodiment, power source 104 constitutes one or more battery units (four shown), whereby no outside electrical power is required to operate motor 56.

Other signal generating means include a user button 106 or an interval timer on circuit board 102 set to activate the automatic flush handle actuation device 50 during the

evening hours when use of the sanitary unit would be infrequent. In the case of the interval timer, a day/night sensor 108 may be provided to deactivate the timer during daytime hours.

Control of the automatic flush handle activation device 50 under an embodiment of the invention can be best understood by reference to the circuit diagram of FIG. 8 and by reference to the parts list of TABLE 1:

TABLE 1

IC1:	PC74HC74, CMOS, PHILIPS OR EQUIVALENT
IC2:	N74HC04, CMOS, MITSUBISHI OR EQUIVALENT
IC3.8:	PC74HC74, CMOS, PHILIPS OR EQUIVALENT
IC4:	HD74HC02, CMOS, HITACHI OR EQUIVALENT
IC5,6,7:	HD4HC00, CMOS, HITACHI OR EQUIVALENT
IC9:	BJ-101, CMOS ASIC, HOLTEK MICRO ELECTRONICS
IC10:	7044A, 4.4V VOLTAGE DETECTOR, HOLTEK MICRO ELECTRONICS
IC11:	1033, 3.3V VOLTAGE DETECTOR, HOLTEK MICRO ELECTRONICS
D1:	INFRARED PHOTO DIODE
D2,3:	INFRARED EMITTING DIODE, 5MM DIAMETER
D4:	RED LED, 5MM DIAMETER
D5:	GREEN LED, 5MM DIAMETER
D6-15:	IN4I4148 SWITCHING DIODE
Q1,3,4:	2SC945 NPN TRANSISTOR OR EQUIVALENT
Q2:	2SA733 PNP TRANSISTOR OR EQUIVALENT
Q5:	2SB562 PNP TRANSISTOR OR EQUIVALENT
Q6:	2SD965 NPN TRANSISTOR OR EQUIVALENT

Activation of the motor 56 of FIG. 8 under a preferred embodiment occurs upon receipt of an activation signal from either of two possible signal sources: (1) an output from a motion sensing detector 100 indicating use of the sanitary facility; or (2) an output of a timer 200. An output from either source results in an activating signal to the motor 56 through a controlling "NOR" gate 201.

For the motor 56 to remain in a deactivated state, the controlling NOR gate 201 must have a logical 0 on each input. A logical 0 at both inputs of NOR gate 201 results in a logical 1 at the output of the NOR gate 201 and a 0 at the output of the inverter 202. A 0 at the output of the inverter 202 causes transistors Q4 and Q5 to remain in a non-conductive state resulting in no voltage being applied to the motor 56.

A logical 0 at both inputs of the NOR gate 201 causes a capacitor C1 of a resistor-capacitor (RC) timing circuit, R1 and C1, to charge to a supply voltage value (3.3V). The momentary application of a positive-going pulse to either input of the NOR gate 201 causes the capacitor C1 of the RC timing circuit to rapidly discharge to 0. A logical 0 at capacitor C1 and at the input to the inverter 202 causes the activation of the motor 56 through transistors Q4 and Q5. The time of activation of the motor 56 is determined by the charging time of the RC timing circuit R1, C1 after the input of the NOR gate 201 has returned to 0.

The occasion for the generation of the positive-going pulse at the input of the NOR gate 201 from the sensor 100 is determined by the state of mode switches S1 and S2. When the mode switches S1, S2 are in the state shown in FIG. 8 (sanitary mode), the motor 56 will be activated both when a user approaches the sanitary facility and when the user leaves the sanitary facility. When only switch S1 is closed (normal mode) the motor 56 will be activated only once for each use of the sanitary facility. When only switch S2 is closed, the

motor 56 will only be activated after every other use of the sanitary facility.

With switches S1 and S2 in the sanitary mode (S1 and S2 as shown in FIG. 8), a logical 0 is applied to one input of NAND gate 204 due to the open state of the switch S2 and because resistor R10 pulls the input to a very low value. The 0 at one input of the NAND gate 204 blocks the passage of any control signals from the sensor 100 through the NAND gate 204. Conversely, the logical 0 from switch S2 causes a logical 1 on NAND gate 205 though inverter 206. The logical 1 on one input of NAND gate 205 allows the passage of control signals from the sensor 100 to the controlling NOR gate 201 through NAND gates 203, 205 and 208.

With the sensor 100 in a deactivated state, a logical 0 is maintained on interconnect 210. The logical 0 on interconnect 210 results (after a time period) in logical 0's on the inputs of inverters 209 and 211 as well. The logical 0's on the inputs of inverters 209 and 211 causes logical 1's to be applied to the inputs of NAND gate 208 and, consequently, a logical 0 at the input of the controlling NOR gate 201.

Upon the activation of the sensor 100, caused by the approach of a user to the sanitary facility, the interconnect 210 rises to a logical 1. The change of interconnect 210 to a logical 1 causes a negative-going pulse to emanate from the output of inverter 211. The negative-going pulse is transferred to the controlling NOR gate 201 causing activation of the motor 56 through NAND gates 208, 205 and 203. The duration of the negative-going pulse from inverter 211 is

determined by resistance and capacitance values of a second RC timing circuit R2, C2.

Likewise, when the user of the sanitary facility leaves (causing deactivation of the sensor 100), a second negative-going pulse emanates from the output of inverter 209. The duration of the second negative-going pulse is determined by resistance and capacitance values of the third RC timing circuit R3, C3.

When the switches S1, S2 of the automatic flush handle activation device 50 are changed to the normal mode (S1 closed; S2 open), the first negative-going pulse is dissipated across resister R4 into the power supply (3.3V) through switch S1. Placing the automatic flush valve activation device 50 in the normal mode causes the motor 56 to be activated only once for each use of the sanitary facility (when the user walks away thereby causing the sensor 100 to become deactivated) by a negative-going pulse from inverter 209 through NAND gates 208, 205, 203.

When the automatic flush handle activation device 50 is placed in the water saver mode (S2 closed), the motor 56 is activated (sanitary facility flushed) only after every other use of the sanitary facility. Activation of the motor 56 after every other use is accomplished by rerouting the activation signal from a path through NAND gates 208, 205 and 203 to a path through NOR gate 207 and NAND gates 204 and 203. Rerouting is accomplished by placing a logical 1 on one input of NAND gate 204 through switch 52 and by placing a logical 0 on NAND gate 205 through use of switch 52 and inverter 206.

The application of a logical 0 on one input of NAND gate 205 blocks signal flow through NAND gate 205. The application of a logical 1 to one input of NAND gate 204 allows signal flow through NAND gates 204 and 203 from NOR gate 207.

NOR gate 207 provides a logical 1 output only when both input signals become a logical 0. Inverter 209, as explained above, provides a negative-going pulse each time the sensor transcends to a deactivated state. D flip-flop 212, on the other hand, toggles between a set and a reset state each time the sensor 100 is activated. Each time the flip-flop 212 is in a reset state when the sensor 100 is activated, the output of the flip-flop 212 (logical 1) blocks (at NOR gate 207) the negative-going pulse from inverter 212. The net result of blocking every other pulse is that whenever the switch S2 is closed, the motor 56 is activated (sanitary facility flushed) only once for each two uses of the sanitary facility.

Turning now to the timing circuit 200, an output activating the motor 56 is provided at the controlling NOR gate 201 from the timing circuit 200 every four hours. The output is provided by dividing a 75 kilo Hertz (kHz) signal within 2^{10}, 2^{5} and 2^{15} counters. The 75 kHz signal is generated by an oscillator consisting of the 2^{10} counter and a resistance-capacitance network R5, C5. The 75 kHz signal is reduced in frequency within the 2^{10} and 2^{5} counters of timer circuit 200 and routed through NAND gates 215 and 213 before being reduced to a four hour signal within the 2^{15} counter of the timer circuit 200.

Upon insertion of batteries into the power unit 104 of the automatic flush handle activation device 50, a D flip-flop 216 is placed into a set state by the interaction of a capacitor C6 and a resister R6. Placing the D flip-flop 215 into a set state provides a calibration interval (7.5 minutes) for adjustments to a variable resister, VR1, controlling the sensitivity of the sensor 100. During normal operation, adjustments may be made to the sensitivity of the sensor 100 by pushing a calibration button S3.

During the calibration interval, a Logical 0 on the $\overline{Q}$ output of the D flip-flop 216 blocks signals passing from the 2^5 counter to the 2^{15} counter at NAND gate 215. A logical 1 on the Q output of the D flip-flop 216 allows a signal to pass directly from the 2^{10} counter to the 2^{15} counter via NAND gates 214 and 213. An output of the 2^{15} counter is then applied to a toggle input resetting D flip-flop 216 after 7.5 minutes.

To aid in the calibration of the sensor 100 during the calibration interval, a light emitting diode (LED) D4 provides visual indication that a user is within range of the sensor 100. A negative-going pulse, B, caused by activation of the sensor 100 is gated during the calibration interval by the Q output of the D flip-flop 216 to the LED D4 via inverter 228 and NAND gates 216, 217 and 220. After the calibration interval, a second output, A, providing visual indication from the sensor 100 is gated to the LED D4 by the $\overline{Q}$ output of the D flip-flop 216 via NAND gates 219, 217 and 220.

Operation of the sensor 100 is facilitated through use of two infrared transmitters D2, D3. A 2.27 Hz signal from an output of the 2^5 counter of the timing circuit 200 is divided in half within a D flip-flop 221 and is shaped within an RC network, R7, C7 before application to transmitting diodes D2, D3 via transistor Q6.

When a user approaches the sanitary facility, infrared light from the transmitting diodes D2, D3, reflected from the user is detected by the sensor 100 and amplified by transistors Q1-Q3. The amplified signal is then shifted across shift registers 221-226 by the 1.15 Hz signal 227 also applied to the transmitting diodes D2, D3. Output signals from the sensor 100 are expanded and delayed within the shaft register 221-226 before application to the interconnect 210 via diodes D6-D8.

Control of the automatic flush handle activator device 50 under an alternate embodiment may be understood by reference to the circuit diagram of FIG. 9. The motor 56 of the modular housing unit 52 as described above may be activated by any one of three possible events: (1) activation by a user of the user button 106; (2) activation of a motion sensor 100; or (3) expiration of a time interval programmed into the interval timer TR2 (FIG. 9). The interval timer may be used during extended periods of inactivity (e.g. every two hours) to activate the flushing mechanism 50. After each event, a normally-closed contact CR1 would reset the timer TR2 for activation after another interval.

Following activation of the motor 56 by a signal gener-ating means, a bridging contact CR1 is closed across the signal generating means electric contact (FIG. 9) to maintain power on the motor 56 for sufficient time for the gear 62 of the reduction gear train 58 to rotate through its predetermined arc. Cycle timer TR1 is programmed to allow sufficient time for such rotation before deactivating the motor 56. Rotation of the gear 62 through the predetermined arc allows the pin 60, attached to the gear 62, to move the flush handle 30 from a first position (FIG. 2) to the second position (FIG. 3). As the flush handle 30 moves to the second position (FIG. 3), the cycle timer TR1 times out, deactivating the motor 56, and allows the spring 38 within the flushing mechanism 10 to return the flush handle 30 to the first position (FIG. 2) as described above, since motor 56 is deactivated.

In another embodiment of the invention (FIGS. 4 and 5), a position sensor 110 (e.g., a limit switch or proximity detector) is used to determine a rotational position of the gear 62. In addition, an actuating element consisting of a cam 112 is rigidly attached to the gear 62 on shaft axis 70 for moving the flush handle 30 between the first position (FIG. 4) and the second position (FIG. 5).

When motor 56 is activated, gear 62 and cam 112 rotate in a counter-clockwise direction. The surface 113 (FIG. 5) of cam 112 is designed such that partial rotation of the cam will move flush handle 30 from the position shown in FIG. 4 to the position shown in FIG. 5, thereby flushing the sanitary unit to which the flushing mechanism 10 is attached.

As cam 112 continues to rotate counter-clockwise, flush handle 30 comes into contact with flat surface 115 of cam 112, and the flush handle moves back to the position shown in FIG. 4 under the influence of spring 38 (FIG. 1). Cam 112 and gear 62 continue to rotate until they reach the position shown in FIG. 4, when rotation is halted by the control elements provided in circuit board 102, which also sets the operating components for the next flushing operation.

Rotational positioning of the gear 62 and cam 112 is provided by a sensor activating element 114 rigidly mounted to the periphery of the gear 62. When the gear 62 is in the first position (FIG. 4) the position sensor 110 is activated by the sensor activating element 114. When the gear 62 rotates out of the first position the position sensor 110 becomes deactivated until the gear 62 (and sensor activating element 114) again returns to the first position.

FIG. 10 is an alternate embodiment circuit diagram of the power/circuit module 54 of the embodiment of FIGS. 4 and 5. The two contacts of the position sensor 110 (normally-open and normally-closed) of FIG. 10 are shown in the deactivated state (sensor activating element 114 not activating the position sensor 110).

As shown in FIG. 10, whenever the position sensor 110 is deactivated by movement of sensor activating element 114 away from the position sensor 110, the motor 56 will continue to rotate until the sensor activating element 114 again engages the position sensor 110. Events that will cause the position sensor 110 to become deactivated include: (1)

activation of the user button 106; (2) activation of the motion sensor 100; or (3) time-out of the timer TR2. Upon deactivation of the position sensor 110 because of any of the three events, the gear 62 and cam 112 will rotate through one complete revolution. Where deactivation of the position sensor 110 is caused by time-out of the timer TR2, the rotation of the cam 112 will also reset the timer TR2 through operation of the normally open set of position sensor 110 contacts.

As demonstrated, the automatic flush handle activation device of the invention provides an easy-to-install, reliable means of flushing sanitary devices without direct user intervention. Such means is provided without the help of a skilled craftsman or outside power sources. The use of a two-piece coupling member allows the automatic flush handle activation device to be attached to existing plumbing fixtures without concern for service interruptions or damage to the existing plumbing fixtures due to twisting forces inherent in prior art devices. Also, the two-piece coupling member allows the flush handle activation device of the present invention to be easily removed and replaced, if necessary.

The foregoing specification describes only the preferred embodiments of the invention as shown. Other embodiments besides the ones described above may be articulated as well. The terms and expressions, therefore, serve only to describe the invention by example only and not to limit the invention. It is expected that others will perceive differences which, while differing from the foregoing, do not depart

from the spirit and scope of the invention herein described and claimed.

I claim:

1. A drive mechanism for a flushing mechanism having a flush handle comprising:

a housing;

battery operated drive means in said housing, said drive means operable to move a flush handle actuating element between a first non-actuating position and a second actuating position;

mounting means adapted to mount said housing to said flushing mechanism and restrain said housing against movement relative to said flushing mechanism when said actuating element is moved between said first position and said second position.

2. The drive mechanism of claim 1 wherein said housing includes:

a battery support structure;

electronic control means electrically connected between said battery support structure and said drive means to control the operation of said drive means.

3. The drive mechanism of claim 2 including signal generating means electrically connected to said electronic control means to initiate actuation of said drive means upon the occurrence of a predetermined event.

4. The drive mechanism of claim 3 wherein said signal generating means comprise sensor means which sense the presence and subsequent absence of a user of a sanitary device with which said flushing mechanism is associated.

5. The drive mechanism of claim 3 wherein said signal generating means is a timing mechanism which generates signals at predetermined time intervals.

6. The drive mechanism of claim 3 wherein said signal generating means:

comprises sensor means which sense the presence and subsequent absence of a user of a sanitary device with which said flushing mechanism is associated; and

comprises a timing mechanism which generates signals at predetermined time intervals.

7. The drive mechanism of claim 1 wherein said mounting means includes a flange surface extending from said housing and adapted to contact said flushing mechanism when said housing is mounted to said flushing mechanism.

8. The drive mechanism of claim 1 wherein said actuating element is driven by said drive means through an arc between said first non-actuating position and said second actuating position.

9. The drive mechanism of claim 8 wherein said actuating element is a pin extending laterally from said drive means.

10. The drive mechanism of claim 1 wherein said actuating element is a cam rotated through 360 degrees by said drive mechanism.

11. The drive mechanism of claim 10 including switch means to stop said cam from rotating after said cam has rotated 360 degrees.

12. An apparatus for automatically actuating the flush handle of the flushing mechanism of a sanitary device, the flush handle extending outwardly from the flushing mechanism, the flushing mechanism including a flat exterior surface adjacent a connecting element connecting the flush handle to the flushing mechanism, and a tension device disposed between said flush handle and said flushing mechanism to urge said flush handle back to a first position when said flush handle is moved to a second position from said first position, said apparatus comprising:

a housing,

battery operated drive means in said housing, said drive means operable to move said flush handle from said first position to said second position;

sensing means operably connected to said drive means to detect a signal generated upon use of said sanitary device and actuate said drive means in response to said signal;

said housing removably mounted to said flushing mechanism and having a flange surface abutting the flat surface of the flushing mechanism preventing said housing from rotating relative to said flushing mechanism.

13. The apparatus of claim 12 wherein said drive means includes:

a motor powered by said batteries,

said motor operably connected to the flush handle to move said flush handle from said first position to said second position upon generation of said signal by said sensing means;

said tension device returning said flush handle to said first position upon completion of a flushing operation.

14. The apparatus of claim 13 including an actuating element operably connecting the motor to the flush handle and adapted to physically contact said flush handle;

said actuating element moved by said motor upon activation of said motor.

15. The apparatus of claim 14 wherein said actuating element is rotated in a first direction through a predetermined arc by said motor into contact with said flush handle, and is rotated through said arc in a second direction by said tension device.

16. A drive mechanism for a flush lever of a sanitary fixture comprising: an electromechanical actuator, within an enclosure, operably engaging the flush lever; first and second bracket halves projecting from the electromechanical actuator enclosure, substantially enclosing and rigidly engaging a bushing and nut securing the flush lever to the sanitary fixture.

17. The mechanism as in claim 16 wherein opposing faces of the first and second bracket halves comprise a complementary topography to the bushing and nut.

18. The mechanism as in claim 16 further comprising attachment means for biasing the first and second bracket halves against the bushing and nut between the first and second bracket halves.

19. An apparatus for activating a flush lever of a sanitary fixture comprising: an electromechanical actuator,

within an enclosure, operably engaging the flush lever; first and second bracket halves substantially enclosing and rigidly engaging a bushing and hexagonal nut securing the flush lever to the sanitary fixture; attachment means for securing the first and second bracket halves to the electromechanical actuator enclosure; and a power source for the electromechanical actuator.

20. The mechanism as in claim 19 wherein opposing faces of the first and second bracket halves comprise a complementary topography to the bushing and nut.

21. The mechanism as in claim 19 further comprising means for biasing the first and second bracket halves against the bushing and nut located between the first and second bracket halves.

22. A control apparatus for a drive mechanism of a flushing mechanism of a sanitary facility comprising:

a self-contained power source;

a sensor for detecting use of the sanitary facility;

a mode selector interconnected with the sensor providing an output upon selected events of sensor operation including a first mode where an output occurs both in response to approach of a user and in response to withdrawal of the user, a second mode where an output occurs in response to withdrawal of the user, and a third mode where an output occurs in response to withdrawal of every second user; and

means for interconnecting the self-contained power source and drive mechanism in response to the mode selector output.

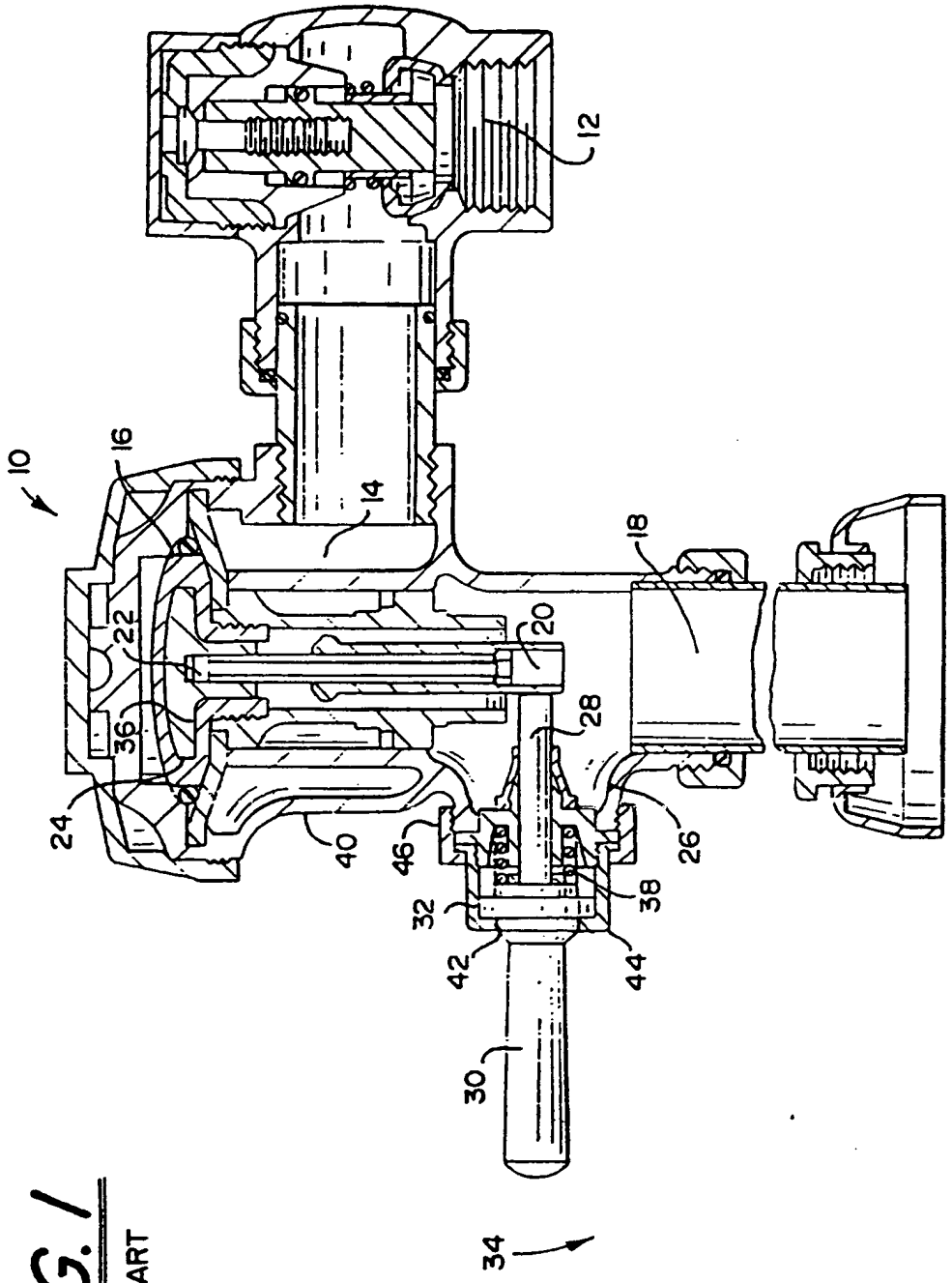

FIG. 1
PRIOR ART

FIG. 2

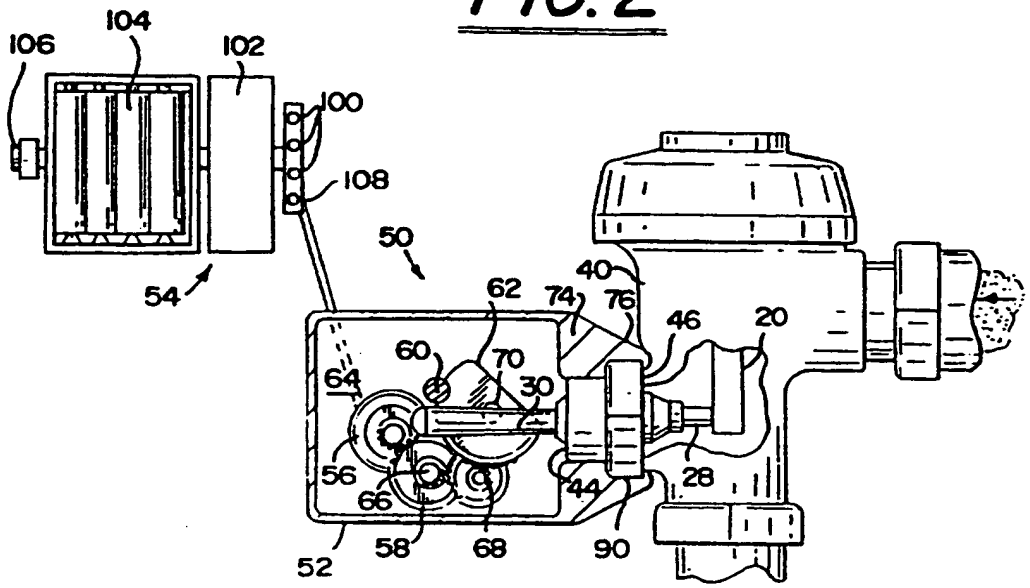
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FIG. 3

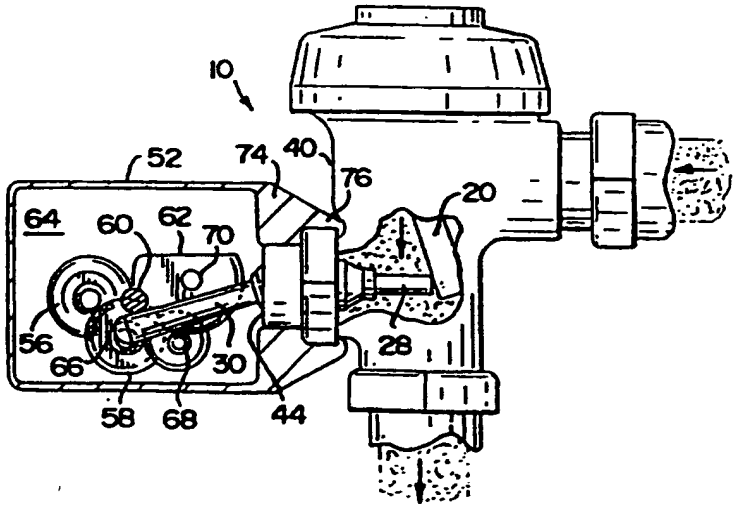
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FIG. 4

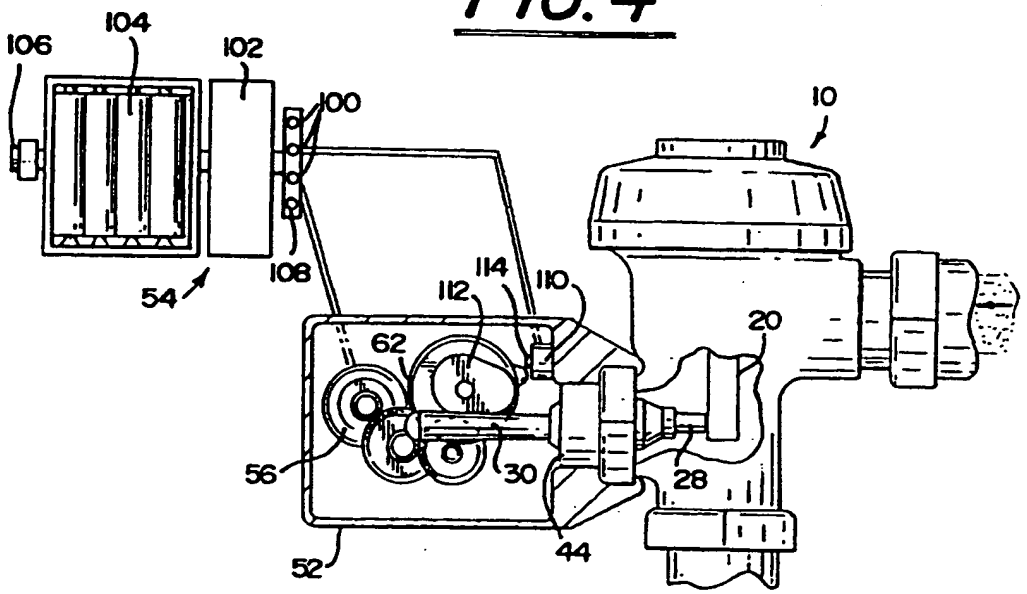
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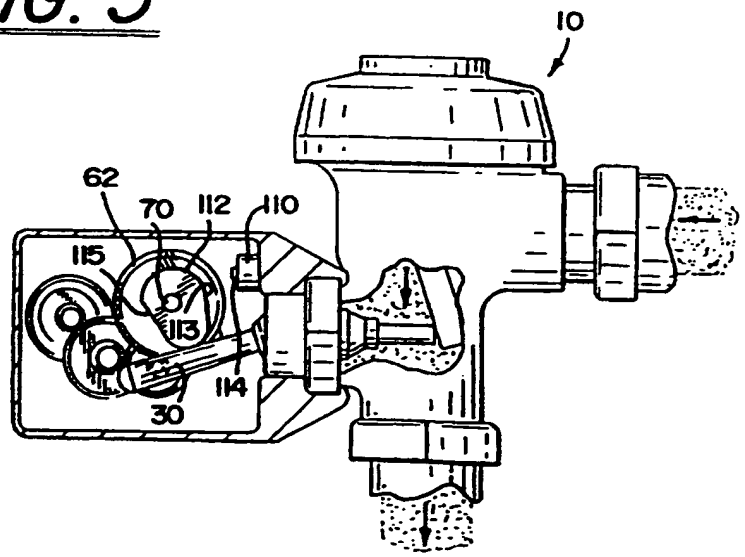
FIG. 5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115
113
114
30

FIG. 6

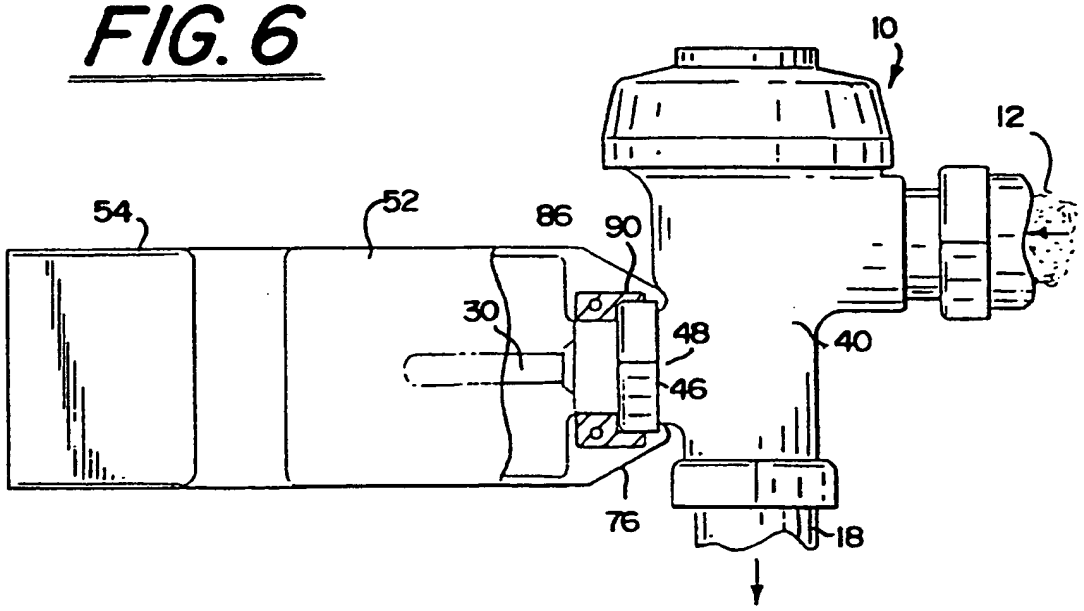
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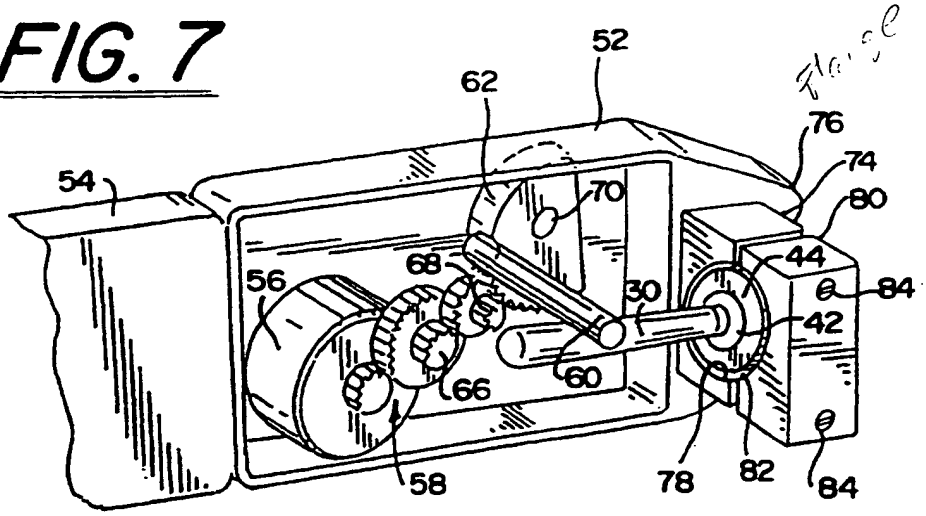
FIG. 7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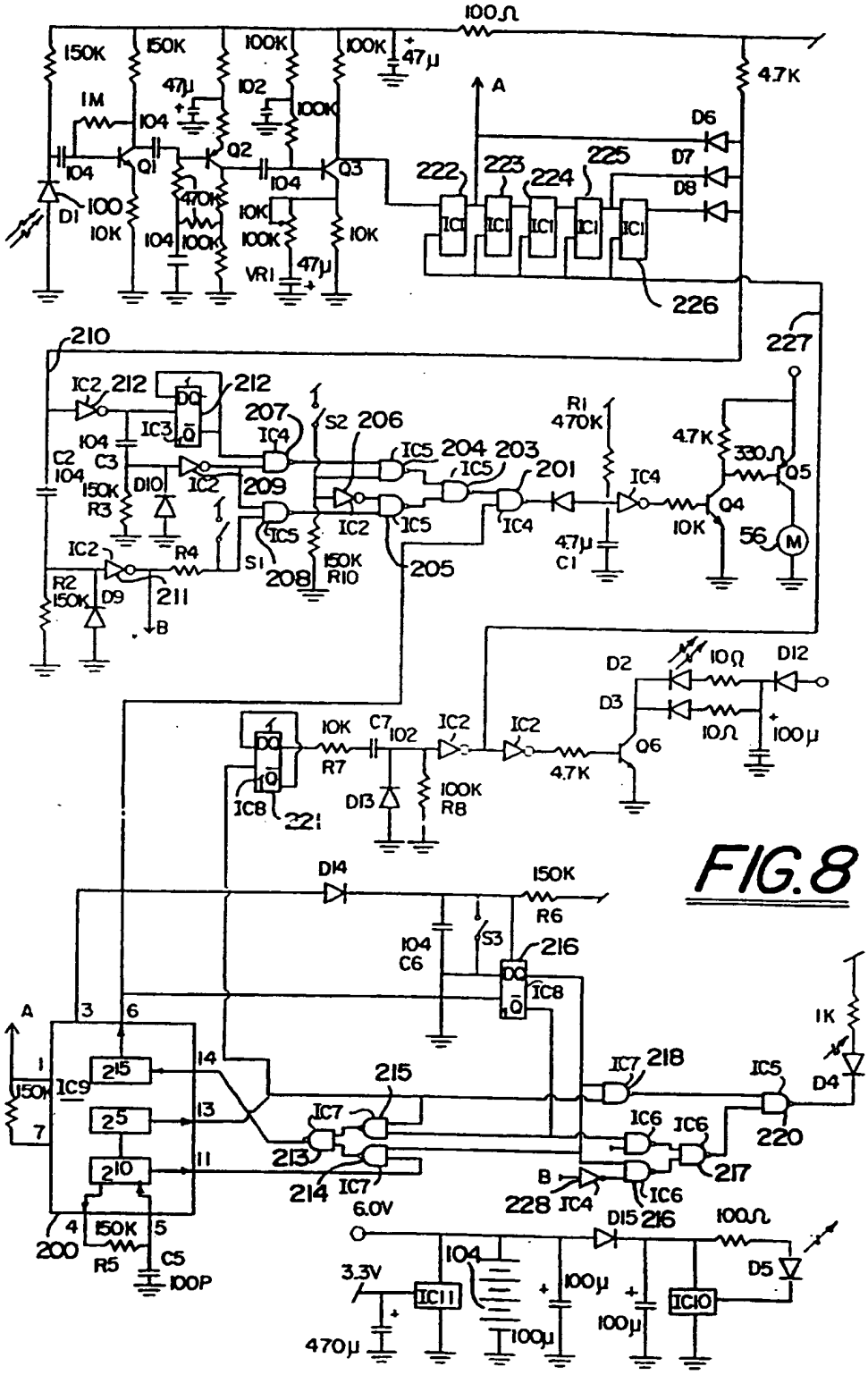
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150K
100K
100K
47μ
4.7K
A
1M
47μ
102
100K
104
Q1
Q2
Q3
D6
D7
D8
222
223
224
225
D1
100
10K
470K
10K
100K
10K
104
100K
VR1
47μ
IC1
226
227
210
IC2
212
212
DQ
IC3
Q
207
IC4
S2
206
R1
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Q5
104
C2
C3
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R3
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IC2
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IC5
204
203
IC5
201
IC4
IC4
Q4
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M
IC2
IC5
IC2
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IC8
221
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R7
C7
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IC2
IC2
4.7K
Q6
D13
100K
R8
D14
150K
R6
104
C6
S3
216
IC8
A
3
6
1
150K
7
IC9
215
215
14
25
13
210
11
IC7
218
IC5
1K
D4
IC7
IC6
IC6
220
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IC7
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D15
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100Ω
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5
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D5
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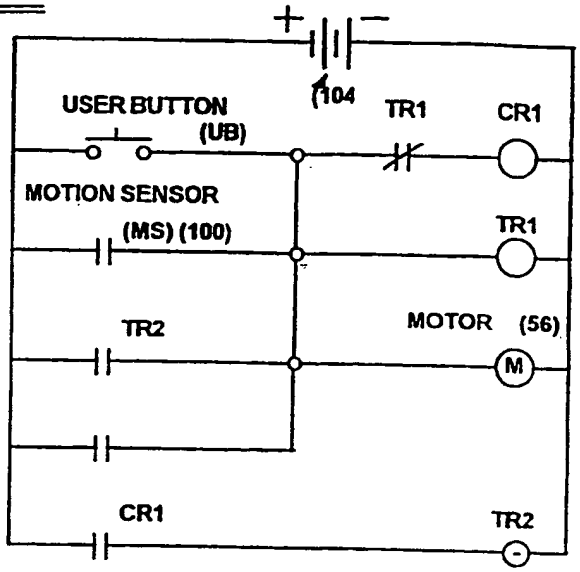
100μ
IC10
470μ
100μ

FIG.8

FIG. 9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USER BUTTON
(UB)
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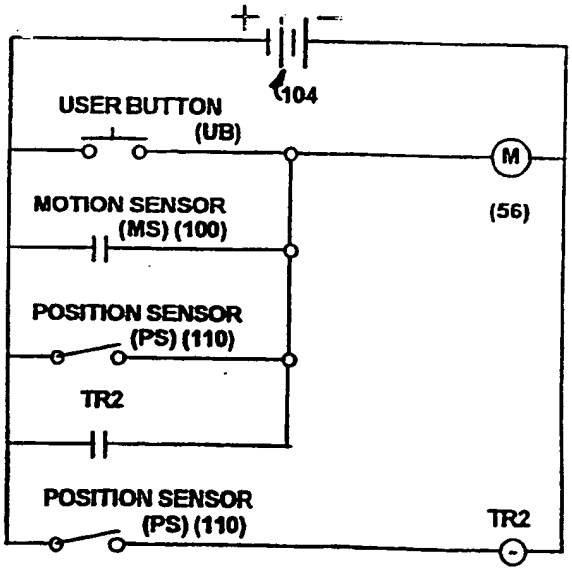
CR1
MOTION SENSOR
(MS) (100)
TR1
TR2
MOTOR (56)
M
CR1
TR2

FIG. 10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TR2
POSITION SENSOR
(PS) (110)
TR2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/13351

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :F16K 31/02
US CL :137/624.11; 251/129.04; 4/305, DIG3
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 137/624.11; 251/129.04, 30.03; 4/305, DIG3, 623

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 5,431,181 (SAADI ET AL) 11 JULY 1995, see col. 4, lines 7-11.	1-4 and 7
A	US, A, 5,224,685 (CHIANG ET AL) 06 JULY 1993, see col. 5, line 51 thru col. 6, line 25.	1, 7, 12, 16 and 19
A	US, A, 2,635,691 (FILLIUNG) 21 APRIL 1953, see col. 2, line 37 thru col. 3, line 5.	8, 10, 15

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 FEBRUARY 1996	13 MAR 1996
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer KEVIN LEE Telephone No. (703) 308-1025

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